Discrimination between aromatic and non-aromatic rice by near infrared spectroscopy: A preliminary study

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Keywords: rice, aromatic rice, adulteration, near infrared spectroscopy, partial least square discrimination

Introduction

Aromatic rice is more expensive than non-aromatic rice. This can prompt adulteration of aromatic rice batches by standard rice and lead to a lack of confidence between producers and consumers. Osborne [1] showed the possibility of discriminating between basmati and other long-grain rice varieties using near infrared (NIR) transmission spectroscopy. Based on these results, the present study focused on the potential of NIR reflectance spectroscopy, applied to a single grain, to discriminate between aromatic and non-aromatic rice.

Experimental procedure

Rice samples

Aromatic rice

Thirteen aromatic rice varieties or genotypes were used for the study. They represented only part of the diversity within the aromatic rice family. Of the varieties imported into France, only *Basmati 370*, which is primarily grown in Punjab and northern India, was used. The others varieties originated from the Philippines (*Azucena*) and Australia (*Goolarah*), and are being used in CIRAD breeding programmes. The samples used in the study were grown under a range of growing conditions, from small and medium-sized trial plots, from various parts of the world and over several years.

Depending on the quality available, the samples of rice were either milled mechanically using a Satake micro rice mill or by hand using a scalpel.

Non-aromatic rice

The material used comprised four commercial samples of non-aromatic rice and two of rice varieties used in CIRAD breeding programmes. The samples were all grown in the Mediterranean Basin and milled in the laboratory.

Near infrared spectroscopy

The NIR spectroscopy analysis of the grain was performed in diffuse reflectance mode from 400 nm to 2,500nm in 2-nm step on a Foss NIRSystems 6500 spinning module, using a small ring cup equipped with a specific aluminium support (Figure 1). Ten grains were analysed per variety. Analyses were performed in random order. The data were processed using WinISI 1.5 software (Foss–Infrasoft International).

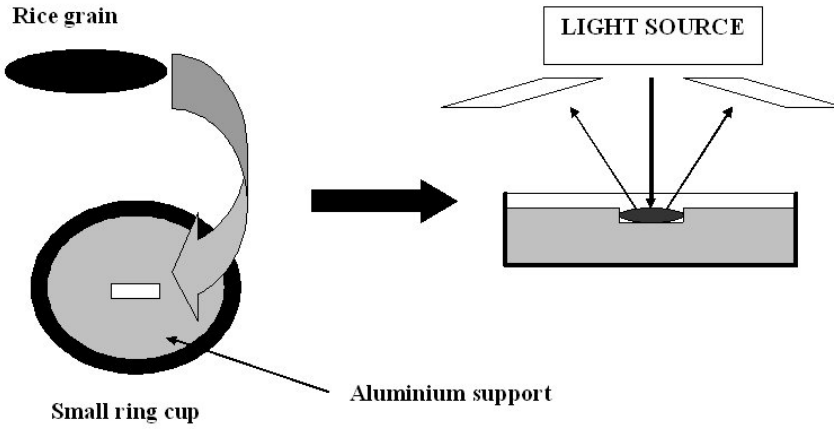

Figure 1. Experimental NIR spectroscopy grain measurement apparatus.

Results and discussion

Discriminant analysis using partial least squares regression (PLS2) was applied in order to sort the 190 spectra collected. The calculation was performed on log (1/R) spectra for the NIR segment from 900 nm to 2500 nm. The PLS2 model was calculated using one dummy variable for both the aromatic and non-aromatic groups. Each of the variables was set to "2" for samples belonging to the group and "1" otherwise. The equation parameters were 0.13 for the standard error of calibration (SEC) and 0.92 for the coefficient of determination (R^2). The standard error of cross-validation (SECV), estimated through a "leave one out" procedure, was equal to 0.18. All grains were assigned to the right group (Table. 1), four aromatic and five non-aromatic grains were uncertain according to the SECV model error and their PLS2 predicted values. The discriminant model enabled classification of rice grains with a 95.3% success rate.

Table 1. Grain NIR spectra classification from partial least square (PLS2) discrimination.

Set	Classified as:-	Type		Total
		Aromatic	Non-aromatic	
Learning set (n = 200)	Aromatic	131	0	131
	Non-aromatic	0	60	60
	Misclassified	0	0	0
	Uncertain	5	4	9
Validation set (n = 20)	Aromatic	10	1	11
	Non-aromatic	0	9	9

The model was validated by predicting 20 new grains taken from two aromatic and two non-aromatic varieties represented in the calibration set, analysing five grains per variety. This validation was a means of evaluating the predictive power of the model and checking the hypothesis that 10 grains were sufficient to represent a variety in the database. This validation resulted in a 95% success rate with only one non-aromatic grain being misclassified as aromatic (Table 1).

A plot of the PLS2 scores for the different grains enabled visualization of the discrimination (Figure 2). The upper and lower limits corresponded to twice the standard deviation of the PLS2 scores for the group. The samples shown as an asterisk are those classed as "uncertain" based on their PLS2 score. In view of the imprecision caused by the standard error of the model, estimated by cross-validation, they could not be allocated to a group at a 95% confidence interval.

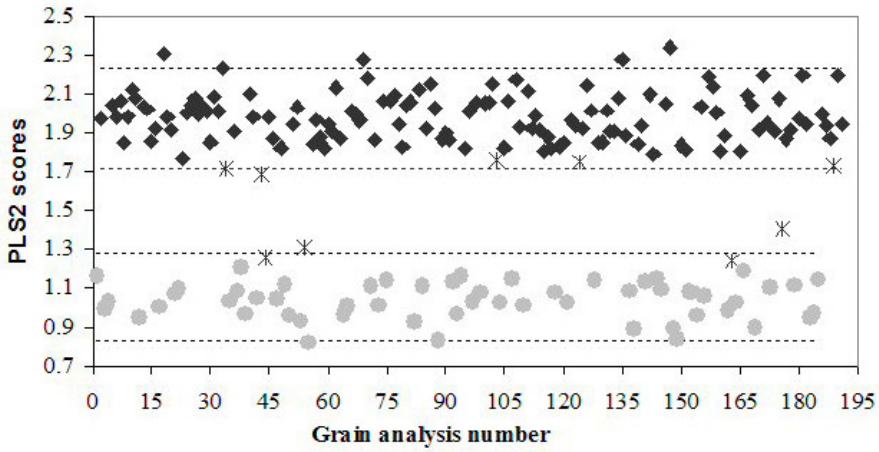

Figure 2. Partial least squares (PLS2) scores of learning set samples of aromatic and non-aromatic grains. ◆ = aromatic rice, ○ = non-aromatic rice, ✳ = uncertain classification.

Conclusion

These results tallied with the observation by Osborne [1] that NIR spectroscopy can be applied to rice recognition. Our study showed that it is possible to discriminate directly between aromatic and non-aromatic rice grains from a range of varieties, based on their spectral fingerprints, obtained in diffuse reflectance mode. In fact, a simple device comprising an aluminium plate with a hole designed to hold a grain of rice and a small ring cup, was sufficient to obtain repeatable rice grain spectra.

These results are promising for establishing a method of checking rice samples, especially for detecting the degree of adulteration of commercial batches. The main difficulty in establishing such a database will be the collection of pure certified varieties. The next step developing an appropriate database will be to extend the calibration set to other varieties and origins. This will need to be combined with determining the optimum number of individual grains to analyse from each batch to detect a desired limit of adulteration for the selected calibration set.

References

1. B.G. Osborne, B. Mertens, M. Thompson and T. Fearn. *J. Near Infrared Spectrosc*. **1**, 77 (1993).